

FLUKA: introduction & geometry

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EIC-TF meeting, 2nd June 2011

Overview

- **FLU**ktuierende **K**Askade: “fluctuating cascade”
- General tool for particle transport & interactions
- Wide range of physics processes & energies
 - e.g. EM interactions from 1 keV to 10 PeV
- Broad range of applications
 - Shielding, dosimetry, particle physics, medical...

Physics

- Elastic, inelastic scattering
- Hadron, nucleus, electron, muon, photon, neutrino
- Energy loss
- Magnetic fields
- Low-E neutrons

Code

- **Not** GNU General Public Licence
 - Must sign user agreement to download
- FORTRAN 77
 - Only supported on Linux + g77 (32 bit)
- Input: text file with option lines (“*cards*”)
 - Normal use doesn’t require programming
 - Special cases require user routines

Tools

- In addition to FLUKA itself...
 - Graphical interface: **Flair**
 - Disk image for Linux virtual machine: **FLUPIX**
 - C++ interface to Geant4 geometry: **FluGG**
 - ... and more

Resources

- Installation of EIC machines:
 - **`/afs/rhic.bnl.gov/eic/PACKAGES/fluka`**
- FLUKA webpage: <http://www.fluka.org/fluka.php>
 - Download: https://www.fluka.org/fluka.php?id=secured_intro
 - Online manual: http://www.fluka.org/fluka.php?id=man_onl
 - Beginner's course: <http://www.fluka.org/fluka.php?id=course&sub=program&navig=2&which=heidelberg2011>

Geometry

- Uses “**Combinatorial Geometry**”
 1. Basic shapes (box, sphere etc): “**bodies**”
 2. Combine with boolean operations
 3. Form complex shapes: “**regions**”
- Duplicate (& translate/rotate) regions: “**lattices**”

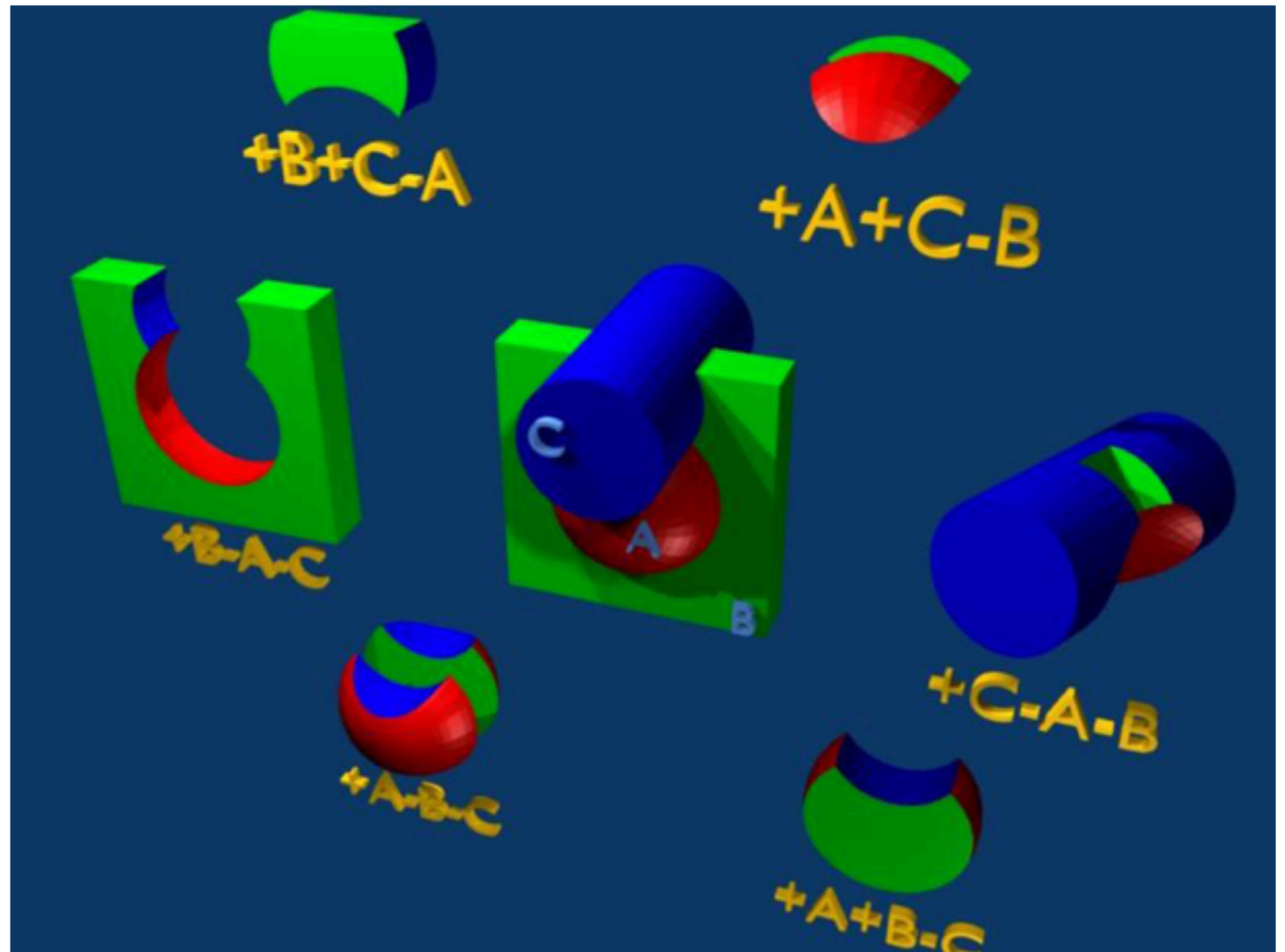
Bodies

- Defined via three-character code
- Each has an **inside** & **outside**
- **Outside** is pointed to by the surface **normal**
- Dimensions in cm

RPP	Rectangular Parallelepiped	Preferred
SPH	Sphere	
XYP, XZP, YZP	Infinite half-space, delimited by xy , xz or yz plane	
PLA	Infinite half-space delimited by a general plane	
XCC, YCC, ZCC	Infinite circular cylinder parallel to x , y or z axis	
XEC, YEC, ZEC	Infinite elliptical cylinder parallel to x , y or z axis	
QAU	Quadric	
REC	Right elliptical cylinder	
TRC	Truncated right-angle cone	
ELL	Ellipsoid of revolution	
RCC	Right circular cylinder	

Regions

- Combine bodies with boolean operators:
 - Subtraction: -
 - Intersection: +
 - Union: |
- Assign material properties to regions (not



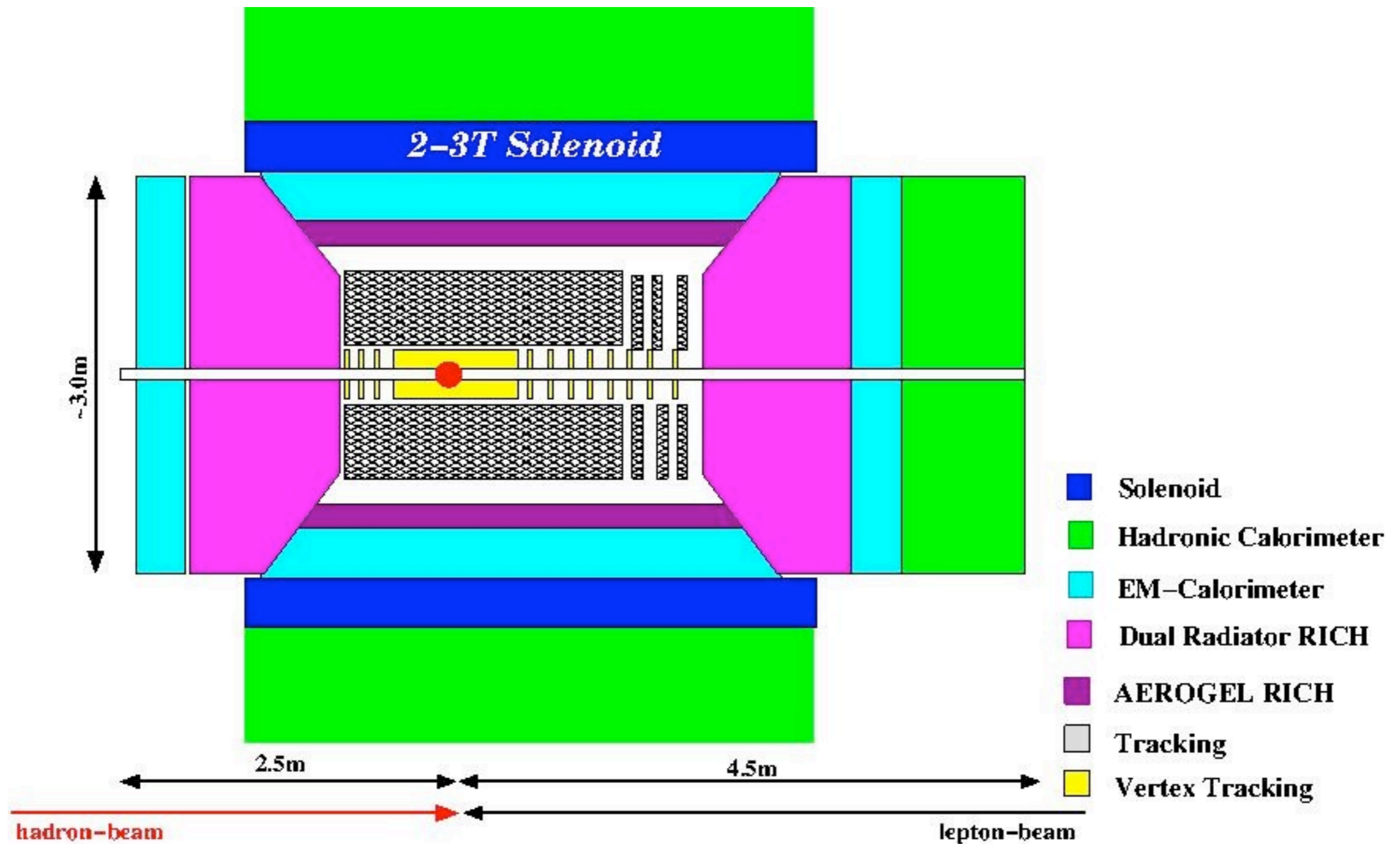
Flair: FLUKA advanced interface

- Graphical interface for FLUKA:
 - Define input (inc. geometry)
 - Run simulation
 - View output
- Geometry viewer & debugger
- Installed on EIC machines:
 - **`/afs/rhic.bnl.gov/eic/PACKAGES/flair`**

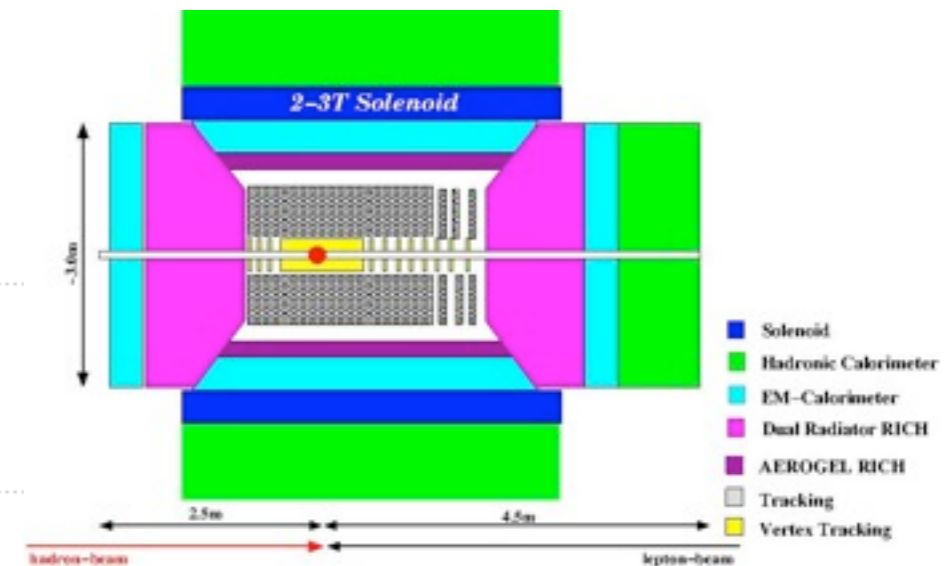
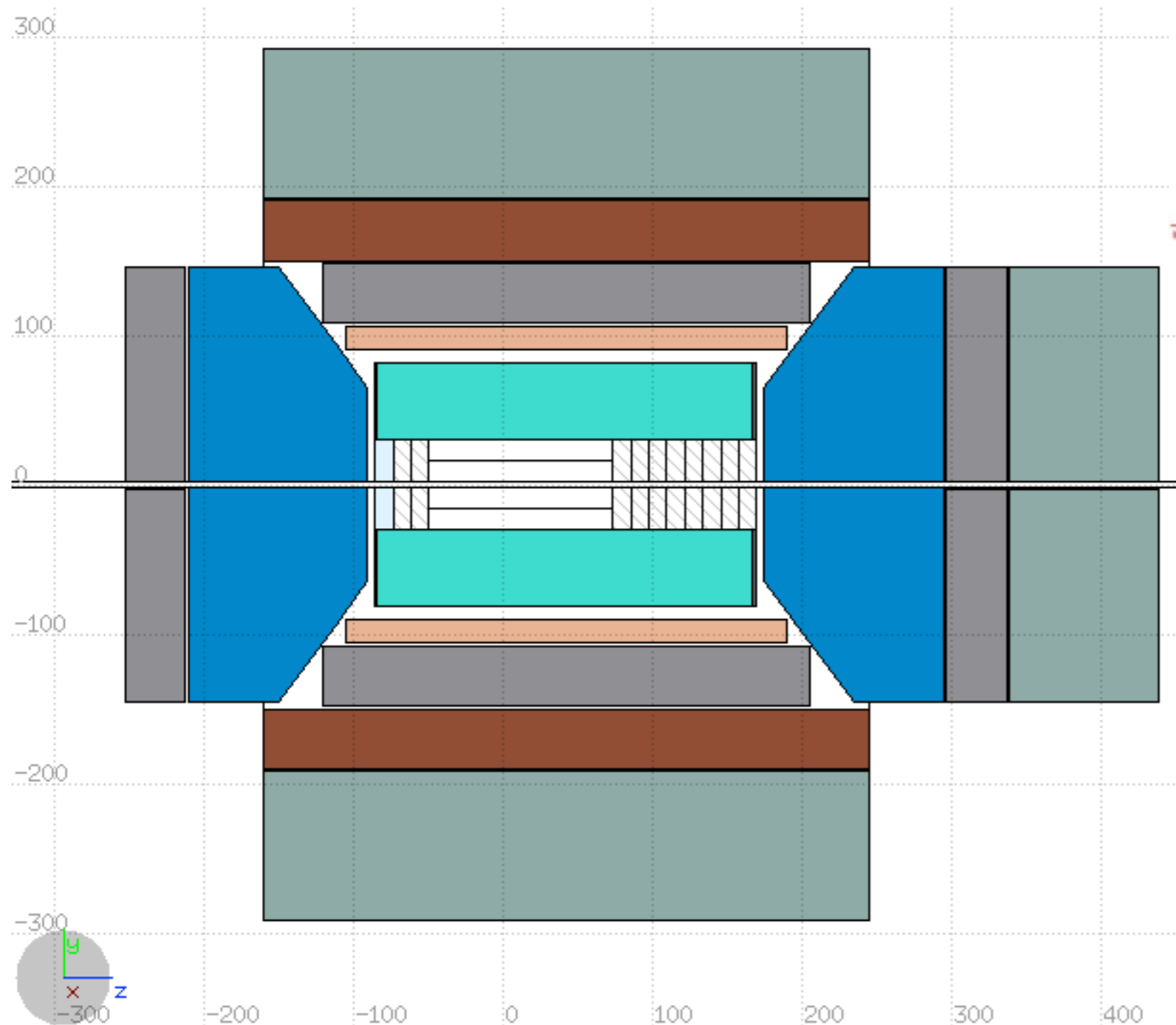
FLUPIX

- FLUKA only supported under **Linux** with **g77**
- For Windows & Mac:
 - Linux virtual machine: **VirtualBox**
 - Disk image with FLUKA, Flair: **FLUPIX**
- [https://wiki.bnl.gov/eic/index.php/
Running FLUKA on non-Unix/Linux systems](https://wiki.bnl.gov/eic/index.php/Running_FLUKA_on_non-Unix/Linux_systems)

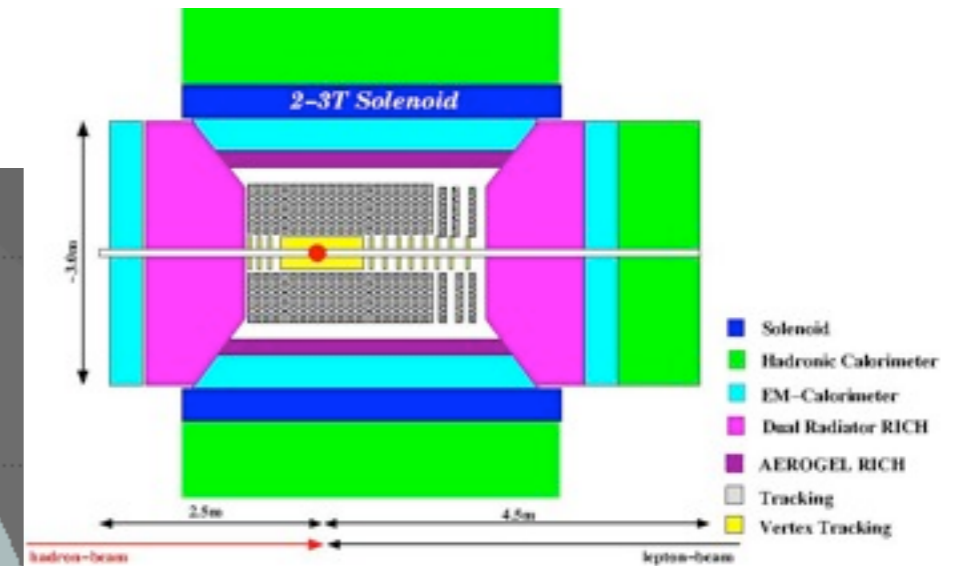
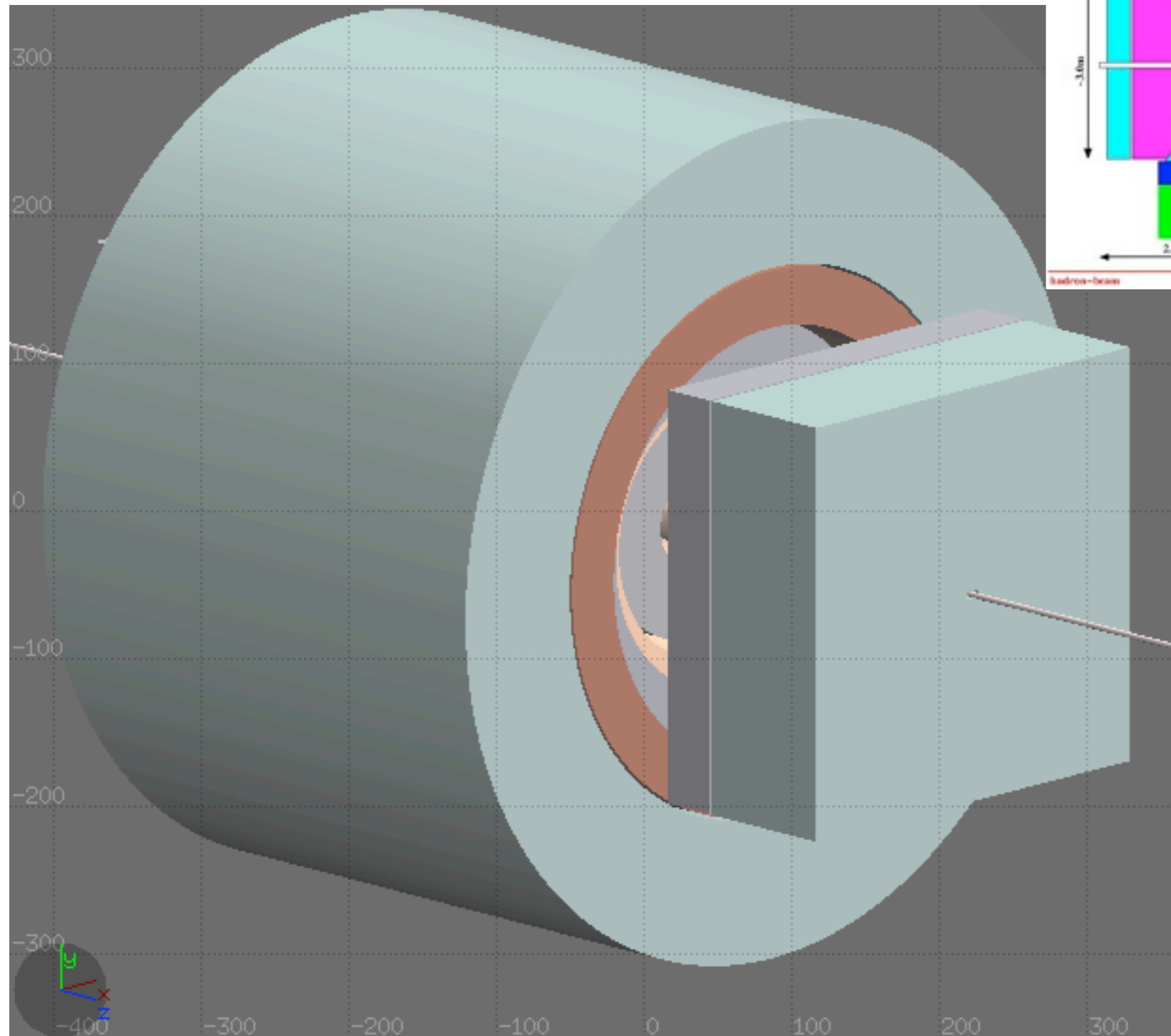
eRHIC - cartoon



eRHIC - FLUKA



eRHIC - FLUKA



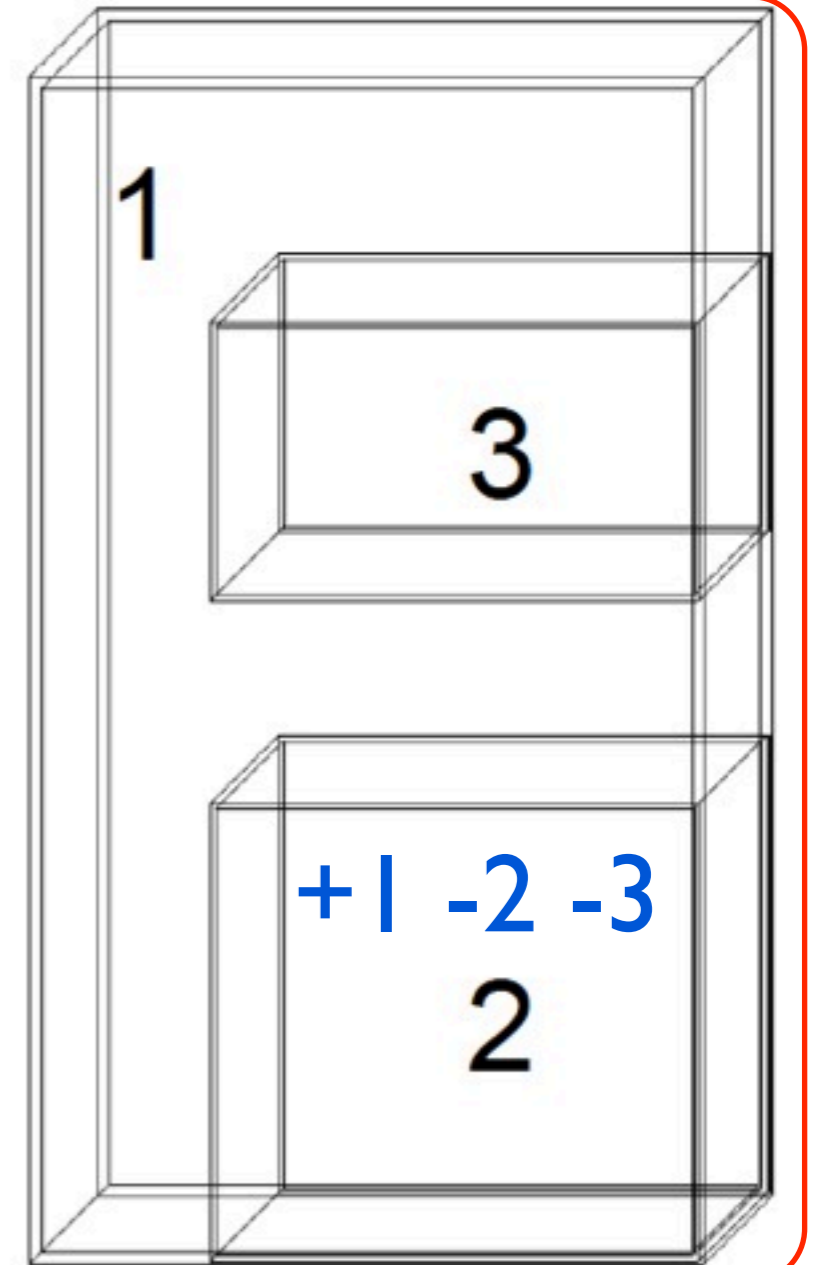
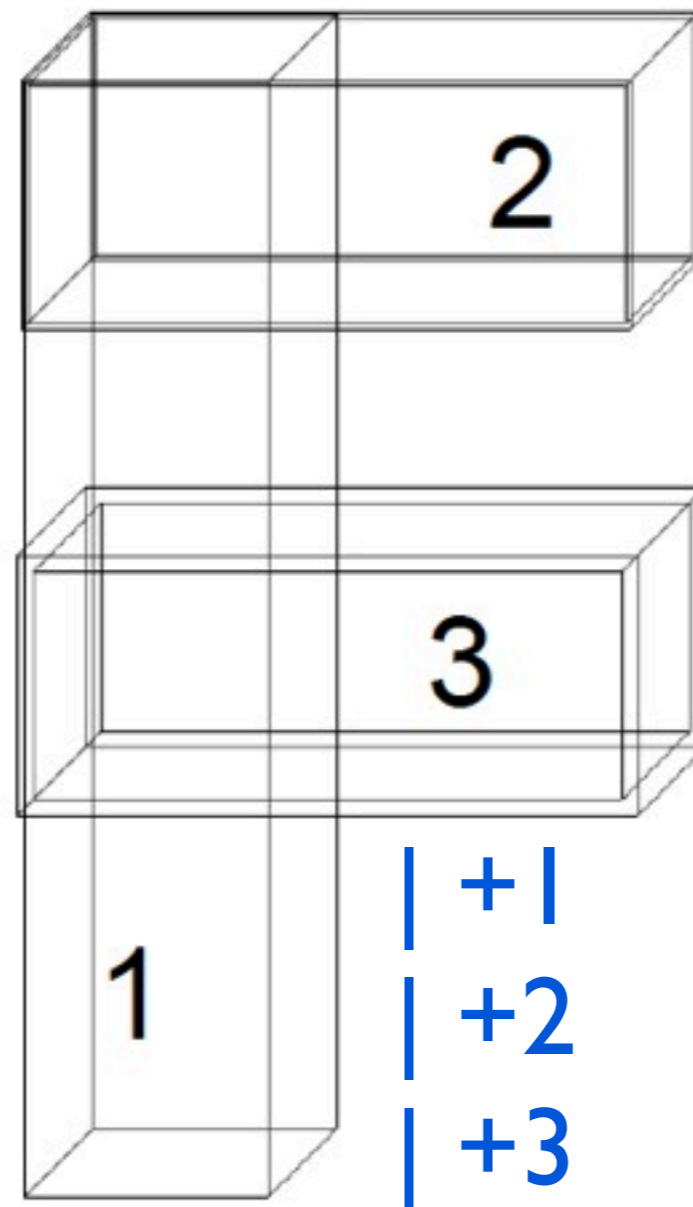
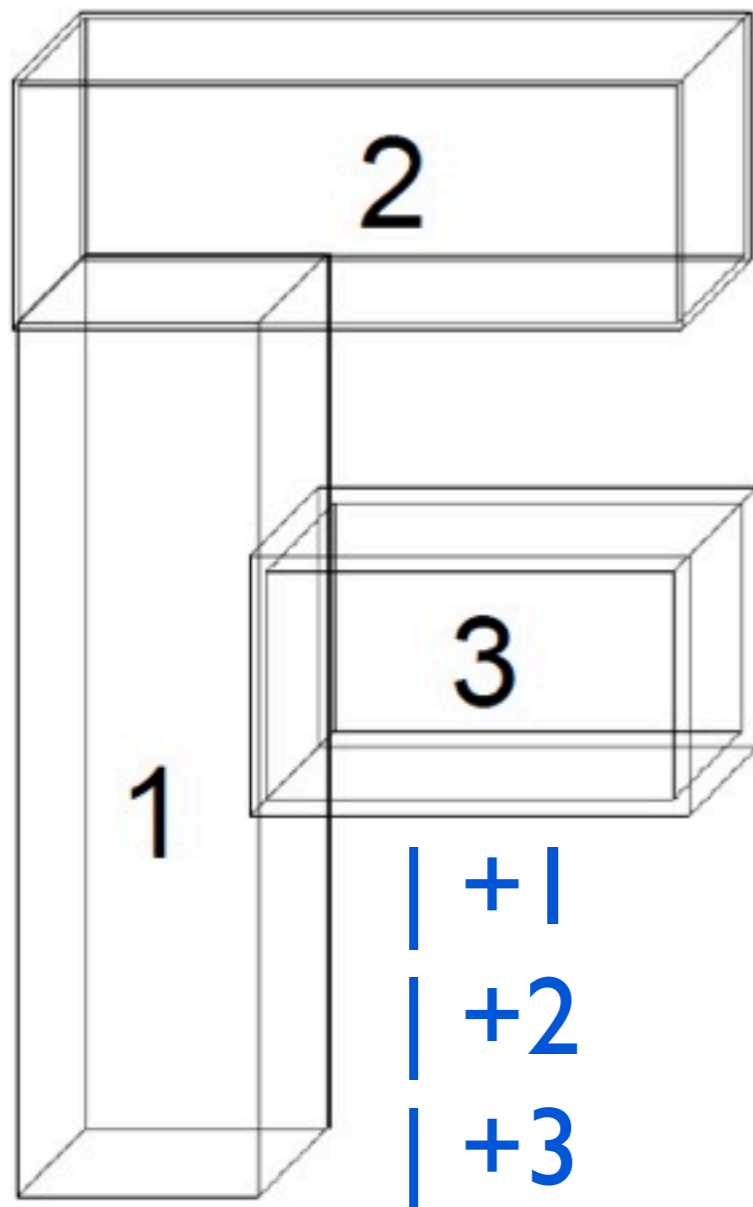
Next

- Pass particles through geometry
 - Ultimately use whole Monte Carlo events
 - Start simple - electrons
- Eventually compare with Geant4
 - FluGG - use same geometry, compare physics?

Extra details...



Regions



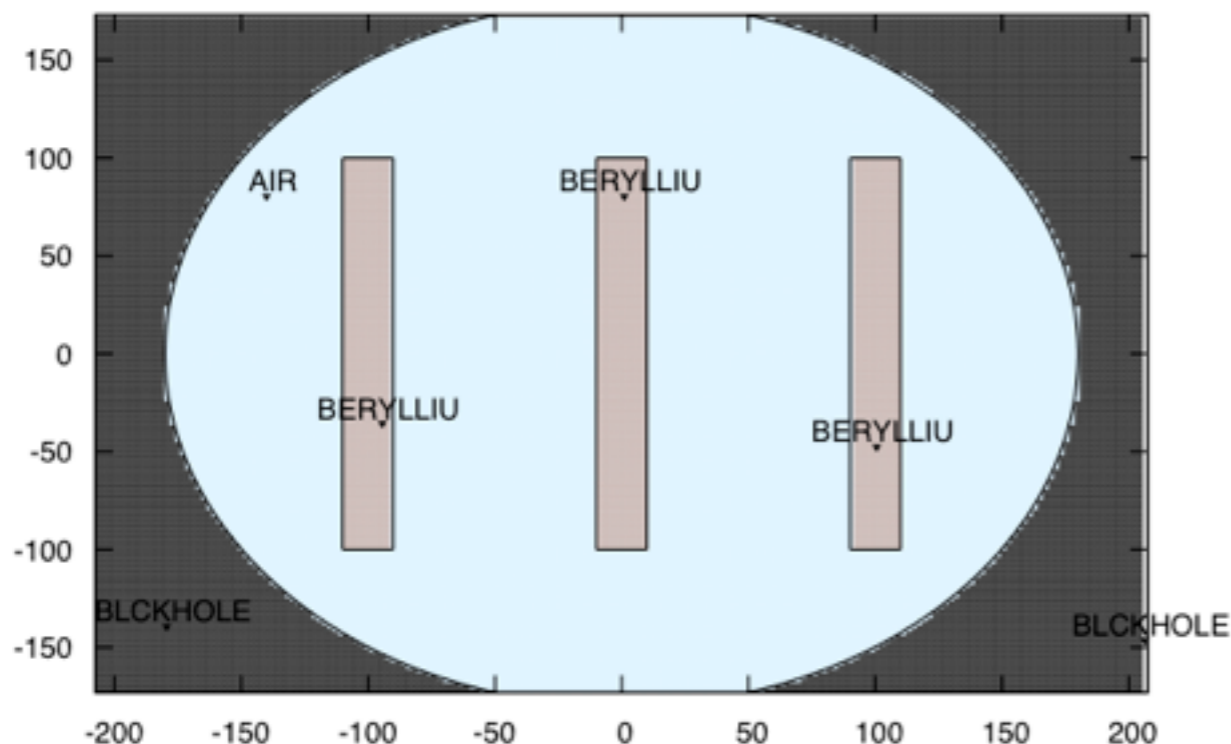
Preferred if 1, 2, 3 are different regions
→ avoids overlapping surfaces

RPP	TARGET1	Xmin: -100. Ymin: -100. Zmin: -110.	Xmax: 100. Ymax: 100. Zmax: -90.
RPP	TARGET2	Xmin: -100. Ymin: -100. Zmin: -10.	Xmax: 100. Ymax: 100. Zmax: 10.
RPP	TARGET3	Xmin: -100. Ymin: -100. Zmin: 90.	Xmax: 100. Ymax: 100. Zmax: 110.
Black body SPH	BLAKHOLE	x: 0.0 R: 300.0	y: 0.0 z: 0.0
Void sphere SPH	VOID	x: 0.0 R: 180.0	y: 0.0 z: 0.0

body definitions
(in flair)

region definitions

REGION	target	expr: +TARGET1 +TARGET2 +TARGET3
REGION	blakhole	expr: +BLAKHOLE -VOID
REGION	void	expr: +VOID -TARGET1 -TARGET2 -TARGET3



- Bodies in a region don't need to be contiguous
- Every point must belong to **one and only one region**
- The whole geometry must be surrounded by a region of "black hole"
- Names are limited to eight characters, case-sensitive